

What is claimed is:

1. A semiconductor ridge laser apparatus comprising:  
a first cladding layer, an active layer, and a second cladding layer formed on  
5 a substrate;  
a ridge formed in the second cladding layer, the ridge having a first section  
with a first width and an output end, and capable of supporting a fundamental lateral  
mode;  
a second section having a second width different than the first width and  
10 capable of supporting the fundamental and higher-order lateral modes; and  
a third section connecting the first and second sections, the third section  
designed to facilitate mode conversion amplification, wherein at least a portion of  
energy in the higher-order lateral modes is converted to energy in the fundamental  
mode.  
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2. The apparatus of claim 1, wherein the third section has a linear taper.
3. The apparatus of claim 1, wherein the first section has a substantially  
uniform width.  
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4. The apparatus of claim 3, wherein the second section has a substantially  
uniform width.
5. The apparatus of claim 1, wherein the first section supports a second-order  
25 mode, and wherein the mode conversion converts energy from the higher-order  
lateral modes to the fundamental and second-order lateral modes.
6. The apparatus of claim 5, further including an optical fiber optically coupled  
to the output end.  
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7. The apparatus of claim 1, further including:  
a first metal contact formed atop the ridge so as to provide an electrical connection to the ridge; and  
a second metal contact formed adjacent the substrate opposite the first  
5 cladding layer so as to provide electrical contact to the substrate.
8. The apparatus of claim 7, further including:  
an injection current source electrically connected to the first metal contact  
for providing an injection current for pumping the active layer.
- 10 9. The apparatus of claim 1, wherein the active layer is one of InGaAs, InGaAsP and AlGaAs.
- 15 10. The apparatus of claim 1, wherein the first and second cladding layers are one of InP and AlGaAs, and InGaAsP.
11. The apparatus of claim 1, wherein the first section has width greater than 2 microns and less than 10 microns.
- 20 12. The apparatus of claim 1, wherein the first section has a length of about 50 microns and a width of about 5 microns.
13. The apparatus of claim 12, wherein the tapered third section has a length of about 150 microns and wherein the taper has a slope of about 0.01.
- 25 14. The apparatus of claim 13, wherein the second section has a length of about 250 microns.
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15. A semiconductor ridge laser apparatus, comprising:

a first active ridge section having a first width formed at an output end of the laser and capable of supporting a fundamental lateral mode and one higher-order lateral mode;

5 a second active ridge section having a second width and capable of supporting the fundamental lateral mode and a first number of higher-order lateral modes; and

a third active ridge section connecting the first and second active ridge sections and designed to facilitate mode conversion amplification of the  
10 fundamental and one higher-order lateral mode in the first active ridge section; and

wherein the fundamental lateral mode and the one higher-order lateral mode form an output beam having a profile that is less astigmatic than a purely fundamental lateral mode output beam profile.

15 16. The apparatus of claim 15, wherein the third active ridge section has a linear taper.

17. The apparatus of claim 25, wherein the one higher-order lateral mode is a second-order mode.

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18. The apparatus of claim 15, further including:

a fourth active ridge section capable of supporting the fundamental mode and a second number of higher-order lateral modes greater than the first number of higher-order lateral modes; and

25 a fifth active ridge section connecting the second and fourth active sections, the fifth active section designed to facilitate mode conversion amplification of energy in the second number of higher-order modes to energy in the fundamental mode and the first number of higher-order modes.

30 19. The apparatus of claim 18, wherein at least one of the third and fifth active ridge sections has a linear taper.

20. The apparatus of claim 15, wherein the output beam has a power greater than 100 mW.

5 21. A method of providing a high-power output beam in a semiconductor ridge laser, comprising:

propagating a fundamental lateral mode and at least one higher-order lateral mode in a ridge waveguiding structure so as to amplify the fundamental lateral mode and the at least one higher-order lateral mode by gain medium amplification;

10 tailoring the ridge waveguiding structure to perform mode conversion amplification of the fundamental lateral mode; and

outputting the energy in the fundamental lateral mode to form the output beam.

15 22. The method of claim 21, wherein performing mode conversion amplification includes interacting the at least one higher-order lateral mode with at least one tapered ridge section formed in the ridge waveguiding structure.

20 23. The method of claim 22, including forming the at least one tapered ridge section to have a linear taper.

24. The method of claim 22, including outputting energy in a second-order lateral mode in combination with outputting energy in the fundamental lateral mode to reduce asymmetry in the output beam as compared to an output beam consisting  
25 of the fundamental lateral mode.

25. The method of claim 24, further including coupling the output beam to an optical fiber.

30 26. The method of claim 21, wherein tailoring the ridge waveguiding structure includes:

forming a first active ridge section having a first width at an output end of the laser, the first active ridge section capable of supporting the fundamental lateral mode;

forming a second active ridge section having a second width greater than the first width and capable of supporting the fundamental lateral mode and the at least one higher-order lateral mode; and

connecting the first and second active ridge sections with an active tapered ridge section.

27. A method of forming a output beam, comprising:

in a semiconductor ridge laser, forming an active waveguiding structure with an upper cladding layer, the waveguiding structure being capable of amplifying light propagating therein;

forming a tapered ridge in the upper cladding layer by forming:

a first section that enables the waveguiding structure to support a fundamental lateral mode and higher-order lateral modes;

a second section having an output end and that enables the waveguide structure to support the fundamental lateral mode;

a tapered section connecting the first and second sections;

performing mode conversion amplification of the fundamental mode by channeling the higher-order lateral modes through the tapered section; and

outputting the energy in the fundamental mode at the output end of the second section to form the output beam.

28. The method of claim 27, including forming the tapered section to have a linear taper.

29. The method of claim 27, including outputting the beam with an output power of 100 mW or greater.

30. The method of claim 29, including providing an injection current to an active layer in the active waveguiding structure, wherein the output power kinks at a first injection current value greater than a second injection current value associated with a uniformly wide ridge.

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31. The method of claim 27, including forming the second section to have a width greater than 2 microns and less than 10 microns.

32. The method of claim 27, including:

10 forming the second section to support a second-order lateral mode;  
performing the mode conversion amplification to include amplifying the second-order lateral mode; and  
outputting the energy in the fundamental mode and the second-order lateral mode at the output end of the second section.

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33. The method of claim 27, including:

coupling the outputted energy to an optical fiber.